Drainage Report for the

Liberty Lake Business Park Parking Lot Expansion

22425 E Appleway Avenue
Liberty Lake, WA 99019

Prepared for:
Trimont Real Estate Advisors

Prepared by:

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This report has been prepared by the staff of DCI Engineers under the direction of the undersigned professional engineer whose stamp and signature appears hereon.

DCI Job No.: #15042-0003
Date: December 15, 2015

The methods, descriptions, and design calculations shown in this design report conform to the Spokane Regional Stormwater Manual (SRSM) and the City of Liberty Lake Design Lake relative to the collection, treatment, and disposal of stormwater runoff.

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Basis of Design of Storm Water System

1.0 Introduction

This report describes the storm water design for an approximately 4.0 acre parking lot expansion located at 22425 East Appleway Avenue in the city of Liberty Lake, Washington. The project will remove an existing grass field and small surface parking lot and replace it with a larger surface asphalt parking lot capable of holding up to 411 vehicles. Improvements will include landscaping, relocation of underground utilities, and new sidewalk around the perimeter of the proposed lot. The parking lot has been designed in accordance with the Liberty Lake Municipal Code with the design of the storm water system falling under the jurisdiction of the Spokane Regional Stormwater Manual.

2.0 Existing Site Conditions

The proposed parking lot expansion is located on 4.0 acres of an existing commercial development. The existing site consists of a relatively flat site that is depressed below the existing public access to Appleway Avenue. An existing grass field is located on the northwest corner of the proposed area with a smaller surface parking lot of approximately 75 vehicles located on the southeast side. The site is located outside of the 100 year floodplain, zone “X”, per FEMA Map Panel #53063C0615D included in Appendix IV.

The existing site slopes are generally flat with only small variations in the mounding within the grass field. The grass field is separated from the existing paved drive aisle by a concrete curb. The existing surface parking lot slopes in the westerly direction towards existing curb cuts that lead to a grass swale on the southeast corner of the site.

3.0 Proposed Storm Water Design Concept

The proposed storm water design concept for this site was designed using the Spokane Regional Stormwater Manual (SRSM). Bio-infiltration swales are proposed for this site, which meets the SRSM requirement for treatment of 90% of the annual runoff volume from pollutant-generating impervious surfaces, and also meets removal requirements for total suspended solids, total petroleum hydrocarbons, metals, and phosphorus. The stormwater facilities are sized to detain and infiltrate the 10-year storm event using the Modified Rational Method.

The proposed design utilizes a system of bio-infiltration swales (formerly known as “208” swales or Grass Percolation Areas (GPA)) that incorporates drywells for infiltrating larger storm events. In general, all storm water runoff from the new impervious area will be captured, treated and infiltrated on site. In accordance with the City Engineer’s recommendations for the site, bio-infiltration swales were designed using the 1133A method as specified in Section 6.7.1 of the SRSM.

The design of the swales is categorized by the below equation 6-1a from the SRSM:

$$V = 1133AP^{1.53}$$

Where V = Volume of bio-infiltration sale (cubic feet)
A = hydraulically connected impervious area to be treated (acres)
P = Precipitation amount for the 6-month NRCS Type II 24 hour water quality design storm (1 inch)

Per the City of Liberty Lake, drywells are an acceptable method of stormwater disposal for this site. Outflow rates of 0.3 CFS (Type 1 drywell) and 1.0 CFS (Type 2 drywell) are allowed.

Runoff from the existing commercial structures are handled by an existing stormwater system that terminates into two drywells for infiltration. This project does not propose to alter the existing drainage system in any way.

4.0 Proposed Drainage System and Basin Summary

The following is a description of the site's post-development drainage basin conditions. A map of the post-developed runoff conditions has been included in Appendix II of this report. The proposed design replaces the existing grass field with an asphalt parking lot. A series of bio-infiltration swales has been designed in accordance with Spokane County standards to mitigate the effect of the increased impervious area.

Basin A consists of an approximately 34,000 square foot section of parking lot in the northern corner of the property, along with the northern half section of the associated drive aisle. Flows from basin A will travel overland into the proposed bio-infiltration swale "A".

Basin B consists of an approximately 20,000 square foot section of parking lot in the western corner of the property, along with the northern half section of the associated drive aisle. Flows from basin B will travel overland into the proposed bio-filtration swale "B".

Basin C consists of an approximately 22,000 square foot section of parking lot in the southwestern corner of the property, along with the southern half section of the associated drive aisle. Flows from basin C will travel overland into the proposed bio-infiltration swale "C".

Basin D consists of an approximately 47,000 square foot section of parking lot in the southeastern corner of the property, along with the southern half section of the associated drive aisle. Flows from basin D will travel overland into the proposed bio-filtration swale "D".

Basin E represents the westerly perimeter of the parking lot near the west corner and consists of an area of approximately 10,000 square feet. Runoff from the surface asphalt parking lot will travel towards the southwest into the proposed bio-infiltration swale labeled "E".

Basin F represents the westerly perimeter of the parking lot near the southwest corner and consists of an area of approximately 8,000 square feet. Runoff from the surface asphalt parking lot will travel towards the southwest into the proposed bio-infiltration swale labeled "F".

Basin G represents the northerly perimeter of the parking lot near the west corner and consists of an area of approximately 8,000 square feet. Runoff from the surface asphalt parking lot will travel towards the northwest into the proposed bio-infiltration swale labeled "G".

Basin H represents the northerly perimeter of the parking lot near the north corner and consists of an area of approximately 6,000 square feet. Runoff from the surface asphalt parking lot will travel towards the northwest into the proposed bio-infiltration swale labeled "H".

Basin I represents the southerly perimeter of the parking lot and consists of an area of approximately 21,000 square feet. Runoff from the surface asphalt parking lot will travel towards the south into the proposed bio-infiltration swale labeled "I".

Table 4-1 below summarizes the site conditions and runoff rates for the nine post-developed drainage basins. See Appendix III for the complete runoff calculations for each of the respective basins.

4-1 Tabular Summary Stormwater Analysis

Drainage Basin	Time of Concentration, Tc (min)	Rainfall Intensity, I (in/hr)	Weighted Coefficient, C	Total Area, A (acres)	Peak Runoff Q10YR (cfs)
Basin A	5.00	2.62	0.80	0.79	1.65
Basin B	5.00	2.62	0.79	0.47	0.97
Basin C	5.00	2.62	0.78	0.49	1.01
Basin D	5.00	2.62	0.80	1.07	2.26
Basin E	5.00	2.62	0.81	0.24	0.51
Basin F	5.00	2.62	0.80	0.19	0.40
Basin G	5.00	2.62	0.70	0.19	0.36
Basin H	5.00	2.62	0.73	0.14	0.28
Basin I	5.00	2.62	0.75	0.47	0.93

Drainage Basin	Total Basin Area (sf)	Roof (sf)	Pavement (sf)	Landscape (sf)	Sidewalk (sf)	Patio (sf)	NPGIS Area (sf)	PGIS (sf)
Basin A	34,211	0	26,871	5,210	2,130	0	5,210	29,001
Basin B	20,422	0	16,914	3,508	0	0	3,508	16,914
Basin C	21,503	0	17,695	3,808	0	0	3,808	17,695
Basin D	46,825	0	36,778	7,107	2,940	0	39,718	7,107
Basin E	10,406	0	8,986	1,420	0	0	1,420	8,986
Basin F	8,367	0	7,040	1,327	0	0	1,327	7,040
Basin G	8,433	0	5,897	2,536	0	0	2,536	5,897
Basin H	6,291	0	4,659	1,632	0	0	1,632	4,659
Basin I	20,501	0	15,872	4,629	0	0	4,629	15,872

5.0 Emergency Overflow

The Spokane Regional Stormwater Manual calls for the design of stormwater systems within the region to account for a 10 year-24 hour design storm event. An overflow structure has been included in each of the proposed swales to convey excess flows prior to causing damage to the adjacent structures.

Each swale has been designed to detain the full volume of a 10 year-24 hour storm event. Drywell inlet grates have been designed with a rim elevation of 6 inches above the finished surface of the swale in accordance with the guidelines set forth in the SRSM. During a 10 year design storm, flows will discharge through the drywell at a rate of 0.3 CFS, allowing the swales to capture the full design volume.

6.0 Erosion Control Considerations

An erosion and sediment control plan is included as part of this project. The Contractor is responsible for ensuring the use of proper erosion control and shall maintain such measures throughout construction, until all pertinent landscaping and permanent erosion control measures (i.e. grassed areas, paved surfaces) have been established. Maintenance shall include daily inspections and repair of the silt fencing. The contractor shall also inspect all erosion control measures following each storm water event during construction or until the permanent measures are established.

Specific temporary measures that will be used during construction include the installation of silt fencing, construction entrance, and lining drainage structures with filter fabric. Silt fencing will be installed along the down gradient property lines, parallel with the existing ground contours or perpendicular to the storm water runoff direction.

Periodically, the temporary erosion control measures must be cleaned of debris and siltation. The contractor shall dispose of the materials so as not to damage any reclaimed areas or create other erosion problem areas. Upon direction by the City of Liberty Lake, Owner, or Engineer, the Contractor may also be required to clean the roadway of siltation or other debris that may occur along or at the construction entrance.

7.0 Operation and Maintenance

The property manager shall maintain responsibility for the proposed storm drain system. Additionally, the owner shall inspect the facilities after any major storm event to ensure that the facilities are operating as designed.

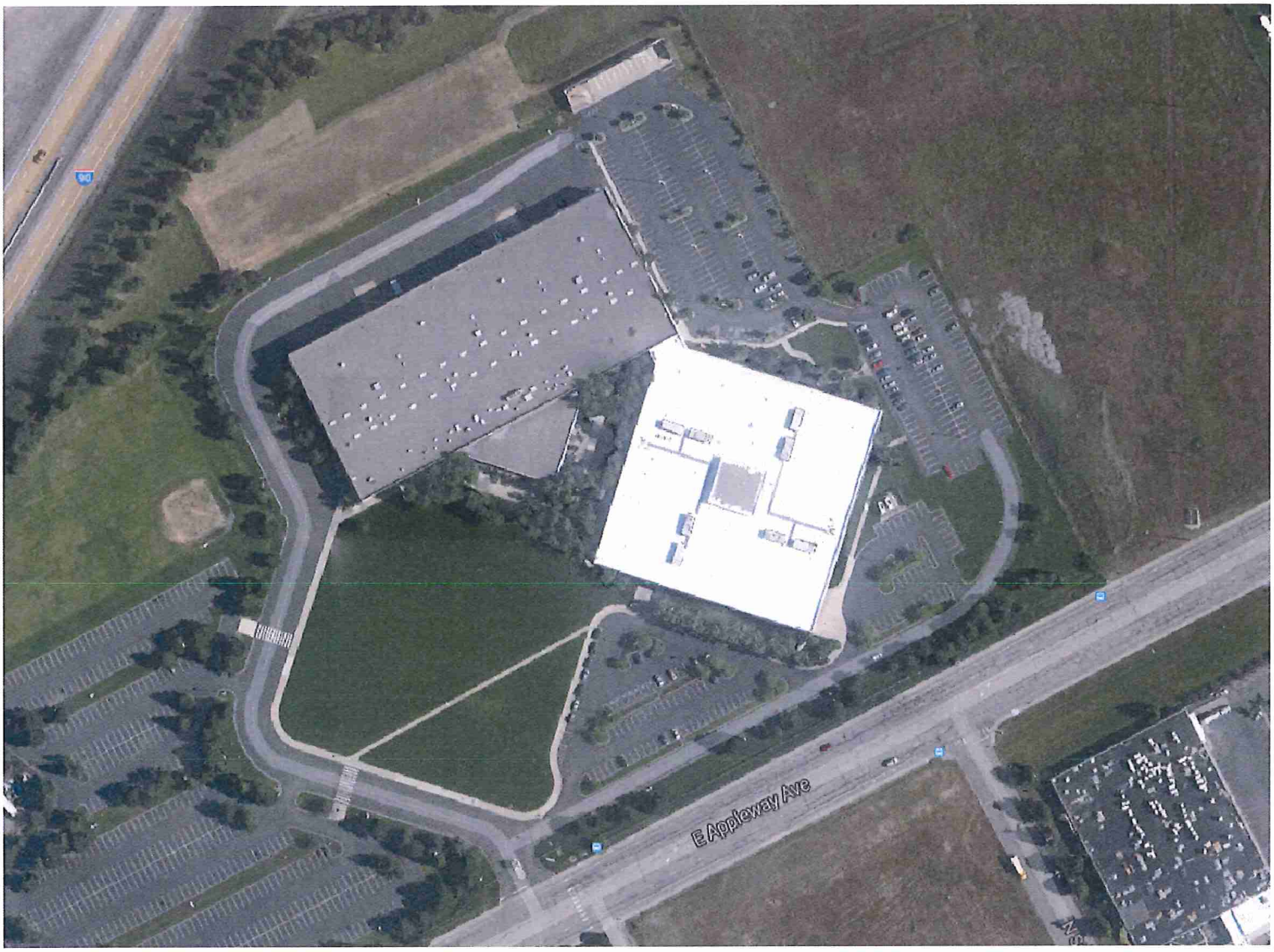
8.0 Summary/Conclusions

The proposed storm water system for this project provides treatment and disposal of runoff as required by the Spokane Regional Stormwater Manual. The proposed parking lot expansion has been designed to utilize overland flow into engineered bio-infiltration swales as a method of stormwater treatment. Overflow structures consisting of Type I standard drywells serve as overflow protection against larger storm events.

During construction, the Contractor shall be responsible for the proper installation and maintenance of all temporary erosion control measures necessary to protect down gradient areas from siltation. The Contractor shall also protect against siltation of the storm water system throughout construction. Long-term maintenance of the designed stormwater system is the responsibility of the property manager and shall occur at a minimum frequency as noted in this report.

The subsurface infiltration system proposed for this project is based solely on post-development conditions of this site. The City of Liberty Lake confirms that sub-surface infiltration is an acceptable method for stormwater disposal on this site.

Appendix I

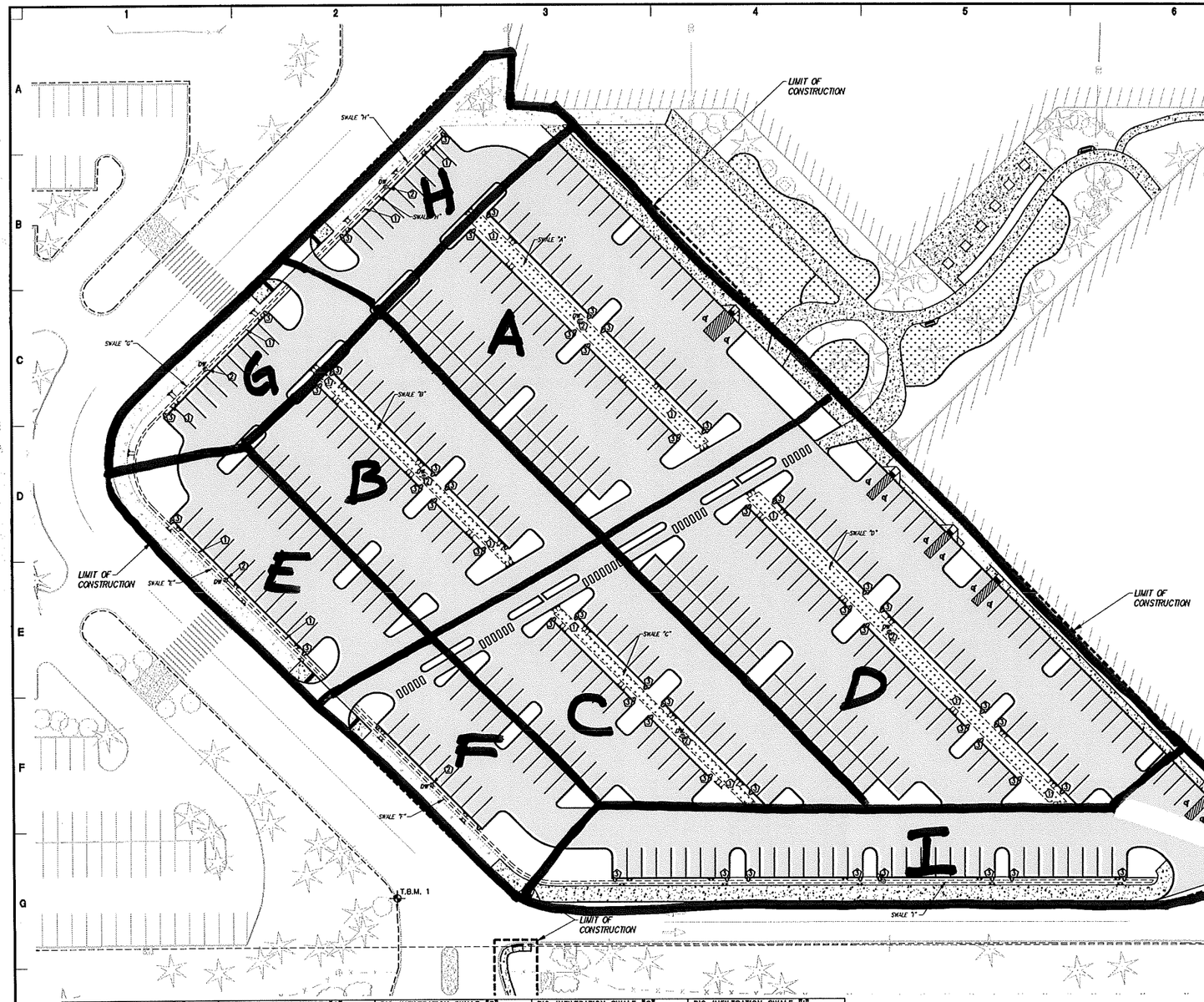


VICINITY MAP

NOT TO SCALE

N

Appendix II



REFERENCE NOTES:

1. CONSTRUCT NEW BIO-INFILTRATION SWALES PER DETAIL X/C5.X.
2. INSTALL NEW TYPE "A" DRYWELL PER SPOKANE COUNTY STD. B-1A.
3. CONSTRUCT CURB INLET PER DETAIL X/C5.X.

LEGEND:

AC PAVEMENT

PORTLAND CEMENT CONCRETE

BIO-INFILTRATION SWALE

PROPOSED TYPE A DRYWELL @DW

SCHEDULE OF S.W. STRUCTURES

SWALE	TOP WIDTH	BOT. WIDTH	LENGTH	SLOPES	VOLUME PROVIDED
A	14 FT.	8.0 FT.	195 FT.	3:1	1,853 CU. FT.
B	11 FT.	5.0 FT.	170 FT.	3:1	1,105 CU. FT.
C	11.5 FT.	5.5 FT.	166 FT.	3:1	1,162 CU. FT.
D	14 FT.	8.0 FT.	270 FT.	3:1	2,565 CU. FT.
E	5.5 FT.	1.5 FT.	220 FT.	2:1	550 CU. FT.
F	5.5 FT.	1.5 FT.	150 FT.	2:1	375 CU. FT.
G	5.5 FT.	1.5 FT.	125 FT.	2:1	313 CU. FT.
H	5.5 FT.	1.5 FT.	100 FT.	2:1	250 CU. FT.
I	5.5 FT.	1.5 FT.	331 FT.	2:1	828 CU. FT.

BIO-INFILTRATION SWALE "A"	BIO-INFILTRATION SWALE "C"	BIO-INFILTRATION SWALE "E"	BIO-INFILTRATION SWALE "G"	BIO-INFILTRATION SWALE "I"
REQUIRED DETENTION VOLUME = 1,506 CU. FT. VOLUME PROVIDED = 1,853 CU. FT. BOTTOM ELEV.= 2073.75 SIDE SLOPES = 3:1	REQUIRED DETENTION VOLUME = 899 CU. FT. VOLUME PROVIDED = 1,162 CU. FT. BOTTOM ELEV.= 2073.75 SIDE SLOPES = 3:1	REQUIRED DETENTION VOLUME = 389 CU. FT. VOLUME PROVIDED = 550 CU. FT. BOTTOM ELEV.= 2073.50 SIDE SLOPES = 2:1	REQUIRED DETENTION VOLUME = 210 CU. FT. VOLUME PROVIDED = 313 CU. FT. BOTTOM ELEV.= 2073.50 SIDE SLOPES = 2:1	REQUIRED DETENTION VOLUME = 697 CU. FT. VOLUME PROVIDED = 828 CU. FT. BOTTOM ELEV.= 2073.00 SIDE SLOPES = 2:1
BIO-INFILTRATION SWALE "B"	**BIO-INFILTRATION SWALE "D"**	**BIO-INFILTRATION SWALE "F"**	**BIO-INFILTRATION SWALE "H"**	
REQUIRED DETENTION VOLUME = 852 CU. FT. VOLUME PROVIDED = 1,105 CU. FT. BOTTOM ELEV.= 2074.00 SIDE SLOPES = 3:1	REQUIRED DETENTION VOLUME = 2,190 CU. FT. VOLUME PROVIDED = 2'565 CU. FT. BOTTOM ELEV.= 2074.00 SIDE SLOPES = 3:1	REQUIRED DETENTION VOLUME = 259 CU. FT. VOLUME PROVIDED = 375 CU. FT. BOTTOM ELEV.= 2073.50 SIDE SLOPES = 2:1	REQUIRED DETENTION VOLUME = 150 CU. FT. VOLUME PROVIDED = 250 CU. FT. BOTTOM ELEV. 2073.50 SIDE SLOPES = 2:1	

CONTRACTOR NOTE

ALL EXISTING UTILITIES SHOWN ON PLANS ARE TO BE VERIFIED HORIZONTALLY AND VERTICALLY PRIOR TO ANY CONSTRUCTION. ALL EXISTING FEATURES INCLUDING BURIED UTILITIES ARE SHOWN AS INDICATED ON RECORD MAPS AND SURVEYS FURNISHED BY OTHERS. WE ASSUME NO LIABILITY FOR THE ACCURACY OF THOSE RECORDS AND SURVEYS. CONTACT THE UTILITY OWNER/AGENCY FOR THE FINAL LOCATION OF EXISTING UTILITIES IN AREAS CRITICAL TO CONSTRUCTION.

GRAPHIC SCALE

30 0 15 30

(IN FEET)
1 inch = 30 ft.

UNDERGROUND SERVICE ALERT
ONE-CALL NUMBER
(800)424-5555
CALL TWO BUSINESS DAYS BEFORE YOU DIG

PREPARED BY:
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SIGNATURE

REGISTERED PROFESSIONAL ENGINEER
STATE OF WASHINGTON
JEFFREY S. FEDDERSEN
12/15/2015

REVISIONS

APPROVALS:

Job No.:	15-42-0003
Proj. Manager:	MHN
Drawn:	JFS
Reviewed:	EA
Dwg. Chk.:	MHN
Date:	12-15-15
Scale:	1" = 30'

PROJECT TITLE:

LIBERTY LAKE BUSINESS PARK
22425 E. APPLEWAY AVENUE
LIBERTY LAKE, WASHINGTON

SHEET TITLE:
STORM DRAINAGE PLAN

SHEET NO.
C1.4

Appendix III

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin A

Total Drainage Area (A)	34,211	s.f.	0.79	ac.
Total PGIS	29,001	s.f.	0.67	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Asphalt (PGIS)	26,871	0.62	0.90	0.56
Sidewalk	2,130	0.05	0.90	0.04
Landscaping	5,210	0.12	0.25	0.03
Building Roof	-	-	0.90	-
TOTAL	34,211	0.79		0.63

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.80

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
78	1200	0.0125

Time of Concentration= 0.58 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	1.65 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.801	
A=	0.79	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	1.65	-	-	-	
2	120	2.62	1.65	366	36	330	for t>Tc
5	300	2.62	1.65	663	90	573	
10	600	1.72	1.08	760	180	580	
15	900	1.34	0.84	845	270	575	
20	1200	1.13	0.71	926	360	566	
25	1500	0.98	0.62	988	450	538	
30	1800	0.88	0.55	1,053	540	513	
35	2100	0.80	0.50	1,108	630	478	
40	2400	0.74	0.47	1,165	720	445	
45	2700	0.69	0.43	1,216	810	406	
50	3000	0.64	0.40	1,249	900	349	
55	3300	0.61	0.38	1,306	990	316	
60	3600	0.58	0.36	1,351	1,080	271	
65	3900	0.55	0.35	1,385	1,170	215	
70	4200	0.53	0.33	1,434	1,260	174	
75	4500	0.50	0.31	1,448	1,350	98	
80	4800	0.48	0.30	1,480	1,440	40	
85	5100	0.47	0.30	1,538	1,530	8	
90	5400	0.45	0.28	1,558	1,620	(62)	
95	5700	0.44	0.28	1,606	1,710	(104)	
100	6000	0.42	0.26	1,612	1,800	(188)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 29,001 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	754	cu.ft.
Total Required Volume for Treatment=	754	
Swale Volume Provided=	926	cu.ft.

Swale Bottom Width=	8.0	ft.	Width at 0.5' depth =	11.0 ft
Swale Bottom Length=	195	ft.	Length at 0.5' depth =	198.0 ft
Swale Depth=	0.5	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	1,560	sf		
Swale Top Area=	2,178	sf		

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	926	cu.ft.	
Required Detention Volume=	580	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	1,506	cu.ft.	
Total Swale Volume Provided=	1,853		

Swale Bottom Width=	8.0	ft.	Width at 1' depth =	14.0 ft
Swale Bottom Length=	195	ft.	Length at 1' depth =	201.0 ft
Swale Depth=	1	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	1,560	sf		
Swale Top Area=	2,814	sf		

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin B

Total Drainage Area (A)	20,422	s.f.	0.47	ac.
Total PGIS	16,914	s.f.	0.39	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Asphalt (PGIS)	16,914	0.39	0.90	0.35
Sidewalk	-	-	0.90	-
Landscaping	3,508	0.08	0.25	0.02
Building Roof	-	-	0.90	-
TOTAL	20,422	0.47		0.37

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.79

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
60	1200	0.015

Time of Concentration= 0.41 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.97 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.788	
A=	0.47	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.97	-	-	-	
2	120	2.62	0.97	215	36	179	for t>Tc
5	300	2.62	0.97	389	90	**299**	
10	600	1.72	0.64	446	180	266	
15	900	1.34	0.50	496	270	226	
20	1200	1.13	0.42	544	360	184	
25	1500	0.98	0.36	580	450	130	
30	1800	0.88	0.33	619	540	79	
35	2100	0.80	0.30	651	630	21	
40	2400	0.74	0.27	684	720	(36)	
45	2700	0.69	0.26	715	810	(95)	
50	3000	0.64	0.24	734	900	(166)	
55	3300	0.61	0.23	767	990	(223)	
60	3600	0.58	0.21	794	1,080	(286)	
65	3900	0.55	0.20	814	1,170	(356)	
70	4200	0.53	0.20	843	1,260	(417)	
75	4500	0.50	0.18	850	1,350	(500)	
80	4800	0.48	0.18	870	1,440	(570)	
85	5100	0.47	0.17	904	1,530	(626)	
90	5400	0.45	0.17	915	1,620	(705)	
95	5700	0.44	0.16	944	1,710	(766)	
100	6000	0.42	0.16	947	1,800	(853)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 16,914 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	440	cu.ft.
Total Required Volume for Treatment=	440	
Swale Volume Provided=	553	cu.ft.

Swale Bottom Width=	5.0	ft.	Width at 0.5' depth =	8.0 ft
Swale Bottom Length=	170	ft.	Length at 0.5' depth =	173.0 ft
Swale Depth=	0.5	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	850	sf		
Swale Top Area=	1,384	sf		

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	553	cu.ft.	
Required Detention Volume=	299	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	852	cu.ft.	
Total Swale Volume Provided=	1,105		

Swale Bottom Width=	5.0	ft.	Width at 1' depth =	11.0 ft
Swale Bottom Length=	170	ft.	Length at 1' depth =	176.0 ft
Swale Depth=	1	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	850	sf		
Swale Top Area=	1,936	sf		

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin C

Total Drainage Area (A)	21,503	s.f.	0.49	ac.
Total PGIS	17,695	s.f.	0.41	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	17,695	0.41	0.90	0.37
Sidewalk	-	-	0.90	-
Landscaping	3,808	0.09	0.25	0.02
Building Roof	-	-	0.90	-
TOTAL	21,503	0.49		0.39

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)= 0.78

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow

Tc=L/K*SQRT(S)	where	Tc=time of concentration in minutes of the longest route that the flow will take
		L=Length in feet
		K=ground cover coefficient (See Table 5-6, Page 5-22)
		S=Average slope in ft/ft

L (ft)	K	S
64	1200	0.01

Time of Concentration= 0.53 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I = 2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA= 1.01 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.785	
A=	0.49	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	1.02	-	-	-	
2	120	2.62	1.02	225	36	189	for t>Tc
5	300	2.62	1.02	408	90	**318**	
10	600	1.72	0.67	468	180	288	
15	900	1.34	0.52	520	270	250	
20	1200	1.13	0.44	570	360	210	
25	1500	0.98	0.38	608	450	158	
30	1800	0.88	0.34	649	540	109	
35	2100	0.80	0.31	683	630	53	
40	2400	0.74	0.29	717	720	(3)	
45	2700	0.69	0.27	749	810	(61)	
50	3000	0.64	0.25	769	900	(131)	
55	3300	0.61	0.24	804	990	(186)	
60	3600	0.58	0.22	832	1,080	(248)	
65	3900	0.55	0.21	853	1,170	(317)	
70	4200	0.53	0.21	883	1,260	(377)	
75	4500	0.50	0.19	892	1,350	(458)	
80	4800	0.48	0.19	912	1,440	(528)	
85	5100	0.47	0.18	947	1,530	(583)	
90	5400	0.45	0.17	959	1,620	(661)	
95	5700	0.44	0.17	989	1,710	(721)	
100	6000	0.42	0.16	993	1,800	(807)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 17,695 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	460	cu.ft.
Total Required Volume for Treatment=	460	
Swale Volume Provided=	581	cu.ft.

Swale Bottom Width=	5.5	ft.	Width at 0.5' depth =	8.5 ft
Swale Bottom Length=	166	ft.	Length at 0.5' depth =	169.0 ft
Swale Depth=	0.5	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	913	sf		
Swale Top Area=	1,437	sf		

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	581	cu.ft.	
Required Detention Volume=	318	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	899	cu.ft.	
Total Swale Volume Provided=	1,162		

Swale Bottom Width=	5.5	ft.	Width at 1' depth =	11.5 ft
Swale Bottom Length=	166	ft.	Length at 1' depth =	172.0 ft
Swale Depth=	1	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	913	sf		
Swale Top Area=	1,978	sf		

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin D

Total Drainage Area (A)	46,825	s.f.	1.07	ac.
Total PGIS	39,718	s.f.	0.91	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	36,778	0.84	0.90	0.76
Sidewalk	2,940	0.07	0.90	0.06
Landscaping	7,107	0.16	0.25	0.04
Building Roof	-	-	0.90	-
TOTAL	46,825	1.07		0.86

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.80

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
78	1200	0.015

Time of Concentration= 0.53 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	2.26 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.801	
A=	1.07	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	2.26	-	-	-	
2	120	2.62	2.26	501	36	465	for t>Tc
5	300	2.62	2.26	907	90	**817**	
10	600	1.72	1.48	1,040	180	860	
15	900	1.34	1.15	1,157	270	887	
20	1200	1.13	0.97	1,267	360	907	
25	1500	0.98	0.84	1,352	450	902	
30	1800	0.88	0.76	1,442	540	902	
35	2100	0.80	0.69	1,517	630	887	
40	2400	0.74	0.64	1,595	720	875	
45	2700	0.69	0.59	1,665	810	855	
50	3000	0.64	0.55	1,710	900	810	
55	3300	0.61	0.53	1,788	990	798	
60	3600	0.58	0.50	1,850	1,080	770	
65	3900	0.55	0.47	1,896	1,170	726	
70	4200	0.53	0.46	1,964	1,260	704	
75	4500	0.50	0.43	1,982	1,350	632	
80	4800	0.48	0.41	2,027	1,440	587	
85	5100	0.47	0.40	2,106	1,530	576	
90	5400	0.45	0.39	2,133	1,620	513	
95	5700	0.44	0.38	2,199	1,710	489	
100	6000	0.42	0.36	2,208	1,800	408	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 39,718 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	1,033	cu.ft.
Total Required Volume for Treatment=	1,033	
Swale Volume Provided=	1,283	cu.ft.

Swale Bottom Width=	8.0	ft.	Width at 0.5' depth =	11.0 ft
Swale Bottom Length=	270	ft.	Length at 0.5' depth =	273.0 ft
Swale Depth=	0.5	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	2,160	sf		
Swale Top Area=	3,003	sf		

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	1,283	cu.ft.	
Required Detention Volume=	907	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	2,190	cu.ft.	
Total Swale Volume Provided=	2,565		

Swale Bottom Width=	8.0	ft.	Width at 1' depth =	14.0 ft
Swale Bottom Length=	270	ft.	Length at 1' depth =	276.0 ft
Swale Depth=	1	ft.		
Swale Side Slope (X:1)=	3			
Swale Bottom Area=	2,160	sf		
Swale Top Area=	3,864	sf		

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin E

Total Drainage Area (A)	10,406	s.f.	0.24	ac.
Total PGIS	8,986	s.f.	0.21	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	8,986	0.21	0.90	0.19
Sidewalk	-	-	0.90	-
Landscaping	1,420	0.03	0.25	0.01
Building Roof	-	-	0.90	-
TOTAL	10,406	0.24		0.19

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.81

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
60	1200	0.015

Time of Concentration= 0.41 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.51 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.811	
A=	0.24	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.51	-	-	-	
2	120	2.62	0.51	113	36	77	for t>Tc
5	300	2.62	0.51	204	90	**114**	
10	600	1.72	0.33	234	180	54	
15	900	1.34	0.26	260	270	(10)	
20	1200	1.13	0.22	285	360	(75)	
25	1500	0.98	0.19	304	450	(146)	
30	1800	0.88	0.17	324	540	(216)	
35	2100	0.80	0.16	341	630	(289)	
40	2400	0.74	0.14	359	720	(361)	
45	2700	0.69	0.13	375	810	(435)	
50	3000	0.64	0.12	385	900	(515)	
55	3300	0.61	0.12	402	990	(588)	
60	3600	0.58	0.11	416	1,080	(664)	
65	3900	0.55	0.11	427	1,170	(743)	
70	4200	0.53	0.10	442	1,260	(818)	
75	4500	0.50	0.10	446	1,350	(904)	
80	4800	0.48	0.09	456	1,440	(984)	
85	5100	0.47	0.09	474	1,530	(1,056)	
90	5400	0.45	0.09	480	1,620	(1,140)	
95	5700	0.44	0.09	495	1,710	(1,215)	
100	6000	0.42	0.08	497	1,800	(1,303)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 8,986 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	234	cu.ft.
Total Required Volume for Treatment=	234	
Swale Volume Provided=	275	cu.ft.

Swale Bottom Width=	1.5	ft.	Width at 0.5' depth =	3.5 ft
Swale Bottom Length=	220	ft.	Length at 0.5' depth =	222.0 ft
Swale Depth=	0.5	ft.		
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	330	sf		
Swale Top Area=	777	sf		

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	275	cu.ft.	
Required Detention Volume=	114	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	389	cu.ft.	
Total Swale Volume Provided=	550		

Swale Bottom Width=	1.5	ft.	Width at 1' depth =	5.5 ft
Swale Bottom Length=	220	ft.	Length at 1' depth =	224.0 ft
Swale Depth=	1	ft.		
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	330	sf		
Swale Top Area=	1,232	sf		

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin F

Total Drainage Area (A)	8,367	s.f.	0.19	ac.
Total PGIS	7,040	s.f.	0.16	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	7,040	0.16	0.90	0.15
Sidewalk	-	-	0.90	-
Landscaping	1,327	0.03	0.25	0.01
Building Roof	-	-	0.90	-
TOTAL	8,367	0.19		0.15

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.80

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
62	1200	0.015

Time of Concentration= 0.42 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.40 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.797	
A=	0.19	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.40	-	-	-	
2	120	2.62	0.40	89	36	53	for t>Tc
5	300	2.62	0.40	161	90	**71**	
10	600	1.72	0.26	185	180	5	
15	900	1.34	0.21	206	270	(64)	
20	1200	1.13	0.17	225	360	(135)	
25	1500	0.98	0.15	240	450	(210)	
30	1800	0.88	0.13	256	540	(284)	
35	2100	0.80	0.12	270	630	(360)	
40	2400	0.74	0.11	283	720	(437)	
45	2700	0.69	0.11	296	810	(514)	
50	3000	0.64	0.10	304	900	(596)	
55	3300	0.61	0.09	318	990	(672)	
60	3600	0.58	0.09	329	1,080	(751)	
65	3900	0.55	0.08	337	1,170	(833)	
70	4200	0.53	0.08	349	1,260	(911)	
75	4500	0.50	0.08	352	1,350	(998)	
80	4800	0.48	0.07	360	1,440	(1,080)	
85	5100	0.47	0.07	374	1,530	(1,156)	
90	5400	0.45	0.07	379	1,620	(1,241)	
95	5700	0.44	0.07	391	1,710	(1,319)	
100	6000	0.42	0.06	392	1,800	(1,408)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 7,040 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	183	cu.ft.
Total Required Volume for Treatment=	183	
Swale Volume Provided=	188	cu.ft.

Swale Bottom Width=	1.5 ft.	Width at 0.5' depth =	3.5	ft
Swale Bottom Length=	150 ft.	Length at 0.5' depth =	152.0	ft
Swale Depth=	0.5 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	225 sf			
Swale Top Area=	532 sf			

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	188	cu.ft.	
Required Detention Volume=	71	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	259	cu.ft.	
Total Swale Volume Provided=	375		

Swale Bottom Width=	1.5 ft.	Width at 1' depth =	5.5	ft
Swale Bottom Length=	150 ft.	Length at 1' depth =	154.0	ft
Swale Depth=	1 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	225 sf			
Swale Top Area=	847 sf			

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin G

Total Drainage Area (A)	8,433	s.f.	0.19	ac.
Total PGIS	5,897	s.f.	0.14	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	5,897	0.14	0.90	0.12
Sidewalk	-	-	0.90	-
Landscaping	2,536	0.06	0.25	0.01
Building Roof	-	-	0.90	-
TOTAL	8,433	0.19		0.14

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.70

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow

Tc=L/K*SQRT(S)	where	Tc=time of concentration in minutes of the longest route that the flow will take
		L=Length in feet
		K=ground cover coefficient (See Table 5-6, Page 5-22)
		S=Average slope in ft/ft

L (ft)	K	S
42	1200	0.015

Time of Concentration= 0.29 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.36 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.705	
A=	0.19	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.36	-	-	-	
2	120	2.62	0.36	79	36	43	for t>Tc
5	300	2.62	0.36	144	90	**54**	
10	600	1.72	0.23	165	180	(15)	
15	900	1.34	0.18	183	270	(87)	
20	1200	1.13	0.15	201	360	(159)	
25	1500	0.98	0.13	214	450	(236)	
30	1800	0.88	0.12	228	540	(312)	
35	2100	0.80	0.11	240	630	(390)	
40	2400	0.74	0.10	253	720	(467)	
45	2700	0.69	0.09	264	810	(546)	
50	3000	0.64	0.09	271	900	(629)	
55	3300	0.61	0.08	283	990	(707)	
60	3600	0.58	0.08	293	1,080	(787)	
65	3900	0.55	0.08	300	1,170	(870)	
70	4200	0.53	0.07	311	1,260	(949)	
75	4500	0.50	0.07	314	1,350	(1,036)	
80	4800	0.48	0.07	321	1,440	(1,119)	
85	5100	0.47	0.06	333	1,530	(1,197)	
90	5400	0.45	0.06	338	1,620	(1,282)	
95	5700	0.44	0.06	348	1,710	(1,362)	
100	6000	0.42	0.06	350	1,800	(1,450)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 5,897 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	153	cu.ft.
Total Required Volume for Treatment=	153	
Swale Volume Provided=	156	cu.ft.

Swale Bottom Width=	1.5 ft.	Width at 0.5' depth =	3.5	ft
Swale Bottom Length=	125 ft.	Length at 0.5' depth =	127.0	ft
Swale Depth=	0.5 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	188 sf			
Swale Top Area=	445 sf			

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	156	cu.ft.	
Required Detention Volume=	54	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	210	cu.ft.	
Total Swale Volume Provided=	313		

Swale Bottom Width=	1.5 ft.	Width at 1' depth =	5.5	ft
Swale Bottom Length=	125 ft.	Length at 1' depth =	129.0	ft
Swale Depth=	1 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	188 sf			
Swale Top Area=	710 sf			

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin H

Total Drainage Area (A)	6,291	s.f.	0.14	ac.
Total PGIS	4,659	s.f.	0.11	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	4,659	0.11	0.90	0.10
Sidewalk	-	-	0.90	-
Landscaping	1,632	0.04	0.25	0.01
Building Roof	-	-	0.90	-
TOTAL	6,291	0.14		0.11

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)=	0.73

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
42	1200	0.015

Time of Concentration= 0.29 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I =	2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA=	0.28 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.731	
A=	0.14	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.28	-	-	-	
2	120	2.62	0.28	61	36	25	for t>Tc
5	300	2.62	0.28	111	90	**21**	
10	600	1.72	0.18	128	180	(52)	
15	900	1.34	0.14	142	270	(128)	
20	1200	1.13	0.12	155	360	(205)	
25	1500	0.98	0.10	166	450	(284)	
30	1800	0.88	0.09	177	540	(363)	
35	2100	0.80	0.08	186	630	(444)	
40	2400	0.74	0.08	196	720	(524)	
45	2700	0.69	0.07	204	810	(606)	
50	3000	0.64	0.07	210	900	(690)	
55	3300	0.61	0.06	219	990	(771)	
60	3600	0.58	0.06	227	1,080	(853)	
65	3900	0.55	0.06	232	1,170	(938)	
70	4200	0.53	0.06	241	1,260	(1,019)	
75	4500	0.50	0.05	243	1,350	(1,107)	
80	4800	0.48	0.05	249	1,440	(1,191)	
85	5100	0.47	0.05	258	1,530	(1,272)	
90	5400	0.45	0.05	262	1,620	(1,358)	
95	5700	0.44	0.05	270	1,710	(1,440)	
100	6000	0.42	0.04	271	1,800	(1,529)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 4,659 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	121	cu.ft.
Total Required Volume for Treatment=	121	
Swale Volume Provided=	125	cu.ft.

Swale Bottom Width=	1.5 ft.	Width at 0.5' depth =	3.5	ft
Swale Bottom Length=	100 ft.	Length at 0.5' depth =	102.0	ft
Swale Depth=	0.5 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	150 sf			
Swale Top Area=	357 sf			

*Is the swale large enough to hold the **Required Volume?** **OK**

6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	125	cu.ft.	
Required Detention Volume=	25	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	150	cu.ft.	
Total Swale Volume Provided=	250		

Swale Bottom Width=	1.5 ft.	Width at 1' depth =	5.5	ft
Swale Bottom Length=	100 ft.	Length at 1' depth =	104.0	ft
Swale Depth=	1 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	150 sf			
Swale Top Area=	572 sf			

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Stormwater Facilities and Detention Basin Design

Date: 12/15/2015
Job No.: 15042-0003
Developer: Trimont Real Estate
Project: Liberty Lake Business Park

Description and Assumptions:
City of Liberty Lake, WA
(See Project Location Map)
Design Frequency=10 years
Basin Area<10 acres, therefore use Rational Formula

Q=CIA	where	Q=Runoff in cfs
		C=Runoff Coefficient
		I=Rainfall Intensity in inches per hour
		A=Contributing Area in acres

1 Determine Weighted Runoff Coefficient, C and Area, A

Sub-Area: Basin I

Total Drainage Area (A)	20,501	s.f.	0.47	ac.
Total PGIS	15,872	s.f.	0.36	ac.

Surface Type	Area (s.f.)	Area (ac.)	C*	C*Area in acres
Parking/Dumpster (PGIS)	15,872	0.36	0.90	0.33
Sidewalk	-	-	0.90	-
Landscaping	4,629	0.11	0.25	0.03
Building Roof	-	-	0.90	-
TOTAL	20,501	0.47		0.35

*From Table 5-5, Page 5-20, "Spokane Regional Stormwater Manual"

Weighted Runoff Coefficient (C)=(sum CA)/(sumA)= 0.75

2 Determine Rainfall Intensity, I

*From Equation 5-11, Page 5-21, "Spokane Regional Stormwater Manual"
Duration (in minutes) is based on the Time of Concentration, Tc

Reach 1: Overland Flow
Tc=L/K*SQRT(S) where Tc=time of concentration in minutes of the longest route that the flow will take
L=Length in feet
K=ground cover coefficient (See Table 5-6, Page 5-22)
S=Average slope in ft/ft

L (ft)	K	S
42	1200	0.015

Time of Concentration= 0.29 minutes

From Page 5-21, "Spokane Regional Stormwater Manual"
Tc shall not be less than 5 minutes, therefore:

Time of Concentration= 5.00 minutes

From Equation 5-13, Page 5-21, "Spokane Regional Stormwater Manual"
Intensity is calculated as:

I=m/TcPOWER(n)

From Table 5-7, Page 5-23, 10-year event, "Spokane Regional Stormwater Manual":

m	n
6.98	0.609

I = 2.62 in./hr.

3 Determine Peak Discharge

Peak 10 yr Discharge = Q10=CIA= 0.93 c.f.s.

4 Detention Basin Design using the Bowstring Method

Time Increment=	5	minutes
Time of Conc.=	5.00	minutes
Desired Outflow=	0.3	cfs
C=	0.753	
A=	0.47	acres

Time (minutes)	Time (seconds)	Intensity (in/hr)	Q (cfs)	Volume In (cu.ft.)	Volume Out (cu.ft.)	Storage (cu.ft.)	
0	0	2.62	0.93	-	-	-	
2	120	2.62	0.93	206	36	170	for t>Tc
5	300	2.62	0.93	373	90	**283**	
10	600	1.72	0.61	428	180	248	
15	900	1.34	0.48	476	270	206	
20	1200	1.13	0.40	522	360	162	
25	1500	0.98	0.35	557	450	107	
30	1800	0.88	0.31	593	540	53	
35	2100	0.80	0.28	624	630	(6)	
40	2400	0.74	0.26	656	720	(64)	
45	2700	0.69	0.24	685	810	(125)	
50	3000	0.64	0.23	704	900	(196)	
55	3300	0.61	0.22	736	990	(254)	
60	3600	0.58	0.21	761	1,080	(319)	
65	3900	0.55	0.19	780	1,170	(390)	
70	4200	0.53	0.19	808	1,260	(452)	
75	4500	0.50	0.18	816	1,350	(534)	
80	4800	0.48	0.17	834	1,440	(606)	
85	5100	0.47	0.17	867	1,530	(663)	
90	5400	0.45	0.16	878	1,620	(742)	
95	5700	0.44	0.16	905	1,710	(805)	
100	6000	0.42	0.15	909	1,800	(891)	

Note: Check formula depending on t< > Tc

5 Determine Volume of Bioinfiltration Swale (Assume trapezoidal cross-section)

Total PGIS Area= 15,872 sf

** Check First: Makesure that the Required Volume is Less than the Volume Provided.

Required Volume from Basin=IPGS Area*1133/43560=	413	cu.ft.
Total Required Volume for Treatment=	413	
Swale Volume Provided=	414	cu.ft.

Swale Bottom Width=	1.5 ft.	Width at 0.5' depth =	3.5	ft
Swale Bottom Length=	331 ft.	Length at 0.5' depth =	333.0	ft
Swale Depth=	0.5 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	497 sf			
Swale Top Area=	1,166 sf			

*Is the swale large enough to hold the **Required Volume?** **OK**

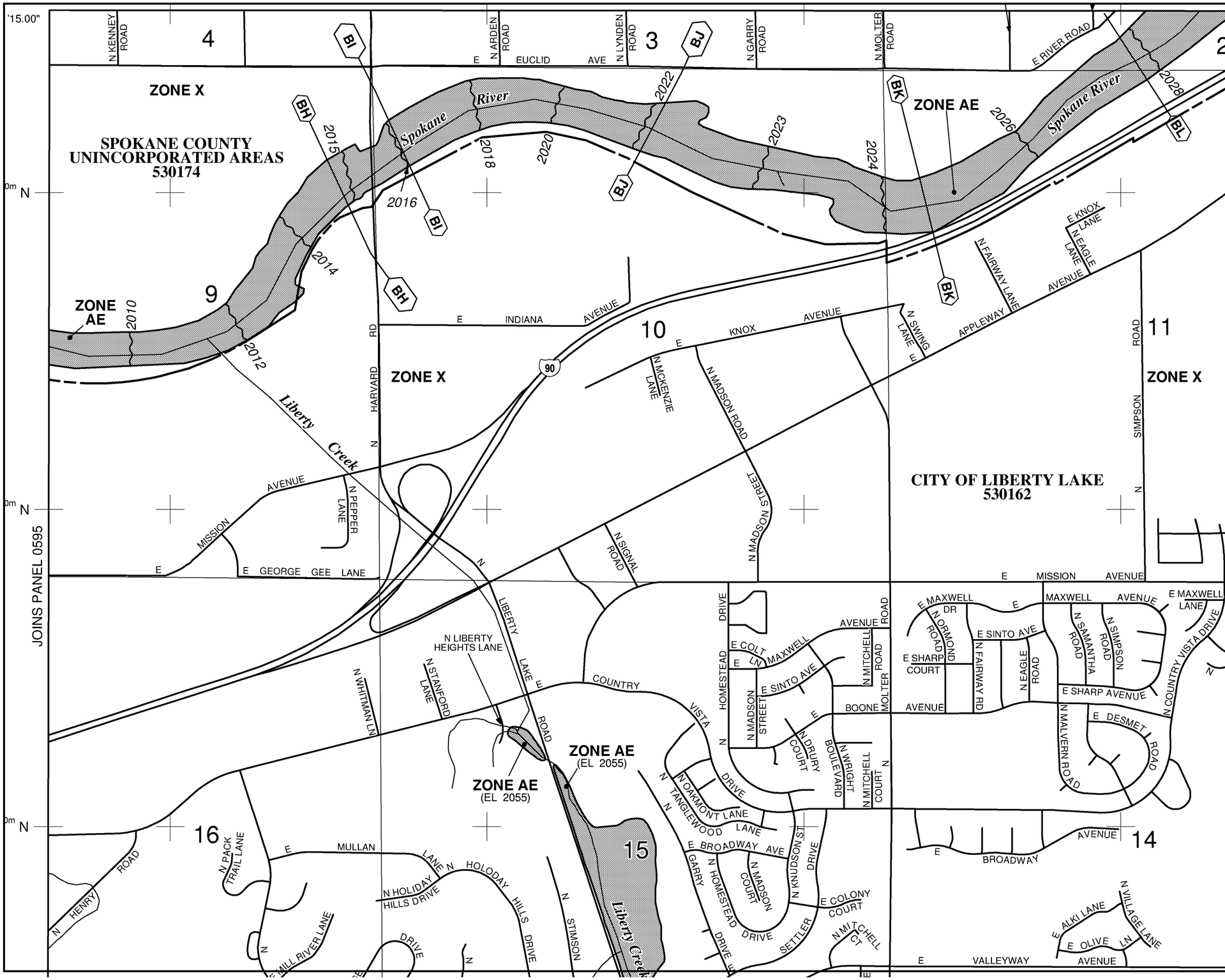
6 Determine Minimum Required Height of Detention Basin above Bio-infiltration Swale
(Assume trapezoidal cross-section)

Provided Treatment Volume=	414	cu.ft.	
Required Detention Volume=	283	cu.ft.	(Maximum value from Step 4)
Total Required Detention Volume=	697	cu.ft.	
Total Swale Volume Provided=	828		

Swale Bottom Width=	1.5 ft.	Width at 1' depth =	5.5	ft
Swale Bottom Length=	331 ft.	Length at 1' depth =	335.0	ft
Swale Depth=	1 ft.			
Swale Side Slope (X:1)=	2			
Swale Bottom Area=	497 sf			
Swale Top Area=	1,843 sf			

*Is the swale large enough to hold the **Total Required Detention** Volume? **OK**

Appendix IV



MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0615D

FIRM
FLOOD INSURANCE RATE MAP
SPOKANE COUNTY, WASHINGTON
AND INCORPORATED AREAS

PANEL 615 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SPOKANE COUNTY	530174	0615	D
LIBERTY LAKE, CITY OF	530162	0615	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
53063C0615D

EFFECTIVE DATE
JULY 6, 2010

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov